Space Weather Technical Forecast

Issued on Sunday, 02 April 2023 at 12:29 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of Minor Geomagnetic Storms throughout. Periods of Active electron fluence expected.

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Solar activity has been Low over the past 24 hours, with one isolated C-class flare observed, a C1.05 at 02/0827 UTC. There are currently two numbered and two unnumbered sunspot regions on the disc, all of which appear to be small and simple with very little magnetic complexity. The analysis and modelling of Coronal Mass Ejections (CMEs) detected in available imagery over the past 24 hours suggest no Earth-directed component.

Solar Wind / Geomagnetic Activity: The solar wind, as measured at L1 by ACE and DSCOVR, has been predominantly Elevated with wind speeds of 550-580 km/s, with ongoing enhancement from coronal hole HSS influence. Density was below average. The phi angle was mostly negative (towards the Sun) but with brief periods of periodic fluctuations to positive (away from the Sun). The IMF was weak (below 8nT), with fluctuations between +6/-6nT in the north-south component. Geomagnetic activity has been Quiet to Unsettled (Kp 1-3), with one Active interval (Kp 4) 01/1500-01/1800 UTC.

Energetic Particles / Solar Radiation: High energy proton enhancement (greater than 10MeV) has been at background levels.

The high energy electron flux (greater than 2MeV), as measured at GOES16 was initially at high levels with a peak of 3.74e3 pfu observed at 01/1525 UTC. Flux levels fell to moderate at 01/2230 UTC and have remained mostly at moderate to background levels since. The associated 24-hour fluence was below the Active (1e8 integrated pfu) threshold to start but on a rising trend, crossing the active threshold by 01/1800 UTC and recording 1.18e8 integrated pfu at 02/0001UTC. Fluence levels fell to Moderate at 02/0900 UTC but remain close to the active threshold.

Four-Day Space Weather Forecast Summary
Solar Activity: Solar activity is expected to remain Low, though confidence reduces through the period.

Solar Wind / Geomagnetic Activity: No Earth-directed CMEs are expected. Although, there have been a number of complex CMEs over the last few days resulting in a slight chance of glancing blows arriving at Earth on Days 1-2 (02-03 Apr).

Solar wind speeds currently at Elevated levels, and are likely to persist at generally Slightly Elevated or Elevated through Days 1 and 2, complicated by any transitory CME impacts. Enhancement to solar winds is expected during Days 3-4 (04-05 Apr) as Earth will likely see the effect of HSSs from approaching coronal holes. Solar wind speeds expected to rise to Elevated or perhaps Strong levels.

Generally Quiet to Unsettled geomagnetic activity is expected, with Active intervals likely and a

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chance of G1/Minor Storm intervals due to CH HSS activity and possible transitory CME effects Days 1-2 (02-03 Apr). Unsettled to Active geomagnetic activity is expected during Days 2-3 (03-04 Apr), with a further chance of isolated G1/Minor Geomagnetic storming due to the likely arrival of coronal hole HSSs and the continuing possibility of glancing CME blows. Remaining generally Unsettled into Day 4 (05 Apr).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV), as observed by GOES-16 is at background levels and is expected to remain so pending any further developments.

The flux at GOES-16 has been at predominantly Moderate levels since 01/2230 UTC, with diurnal fluctuations to High levels likely by Day 2. However, geomagnetic activity is forecast during the period due to coronal hole HSSs and possible transitory CME effects which may see the flux at GOES16 temporarily reduced back towards normal background, adding uncertainty to the forecast. Fluence levels are currently below but close to the Active threshold but are expected to trend upwards to Active, although confidence is low given uncertainty in effects from geomagnetic activity.

Fluence levels are currently just below the Active threshold, but are expected to increase to Active and generally remain so. However, uncertainty in the flux at GOES16 leads to reduced confidence in fluence levels during the period.

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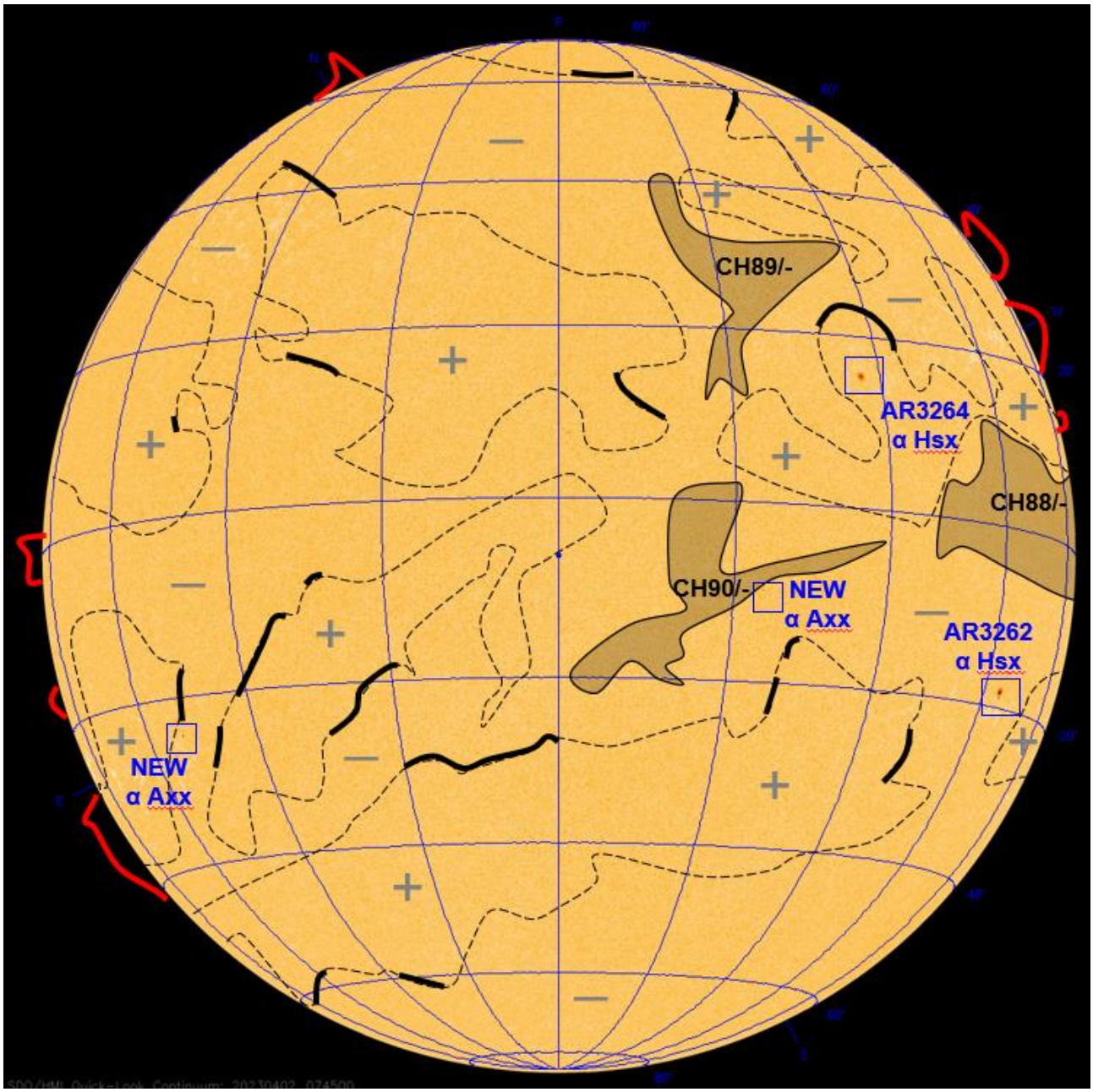
Figure 1. Solar Analysis Valid 02/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

There have been a number of generally small but complex CMEs over the last few days, and although analysis and modelling would suggest that these were not Earth-directed, there remains a slight chance of glancing blows arriving at Earth later on Day 1 (02 Apr) or on Day 2 (03 Apr), supported by a small number of MOSWOC ENLIL ensemble perturbations. The most likely of these looks to be associated with a far-sided halo CME from 01 Apr.

Solar winds are currently at Elevated levels, likely a result of the ongoing (but waning) influence of a

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HSS from CH88/-. Wind speeds are likely to remain Elevated levels, perhaps peaking briefly at Strong, before gradually declining to Slightly Elevated levels through Day 2 (03 Apr), although this may be complicated by any transitory CME impacts. Through Days 3-4 (04-05 Apr) Earth is expected to begin to connect to the HSS from approaching coronal holes 89 and 90, with CH90/- in the southern hemisphere expected to be the dominate feature. Solar wind speeds expected to return to Elevated or perhaps Strong levels.

Generally Quiet to Unsettled geomagnetic activity is expected initially, with an increasing probability of Active or G1/Minor Storm intervals late Day 1 into Day 2 due to the combined influence of coronal hole HSS and possible transitory CME effects. Into Days 2-3, Unsettled to Active geomagnetic activity is expected, with a chance of G1/Minor storming due to the arrival of the CH HSS of CH90/- and the continuing risk of CME glancing blows. In the absence of any further CMEs, activity should remain generally Unsettled on Day 4 (05 Apr).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	30	50	50	30
Strong	G3	No	1	5	5	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil expected.

Figure 2: Global Geomagnetic Activity over last 72 hours.

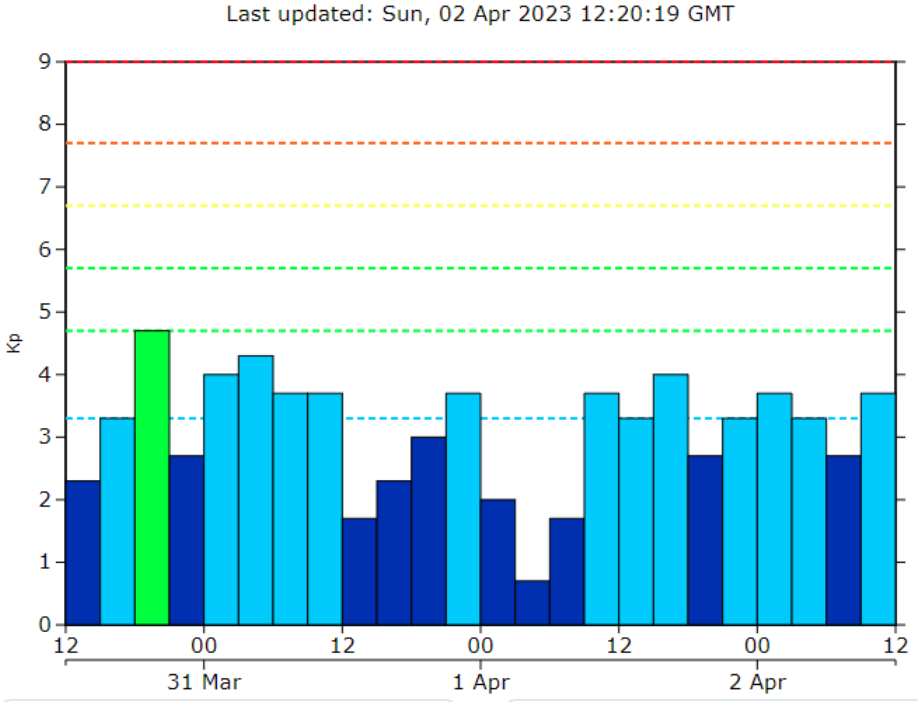

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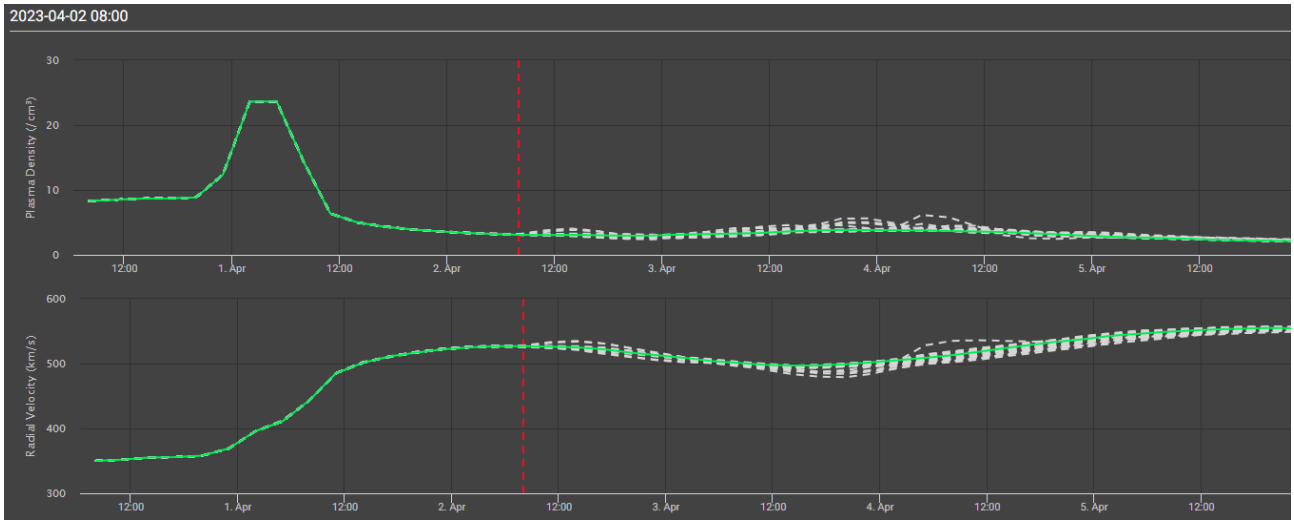
Figure 3: : Latest MOSWOC ENLIL Ensemble output, showing possible glancing CME impacts



Radio Blackouts - X-Ray Flares:

The four-day forecast period is currently expected to see a generally muted flare risk due to the presence of only a few simple regions on the visible disc.

There is a signal for returning regions to potentially arrive across the eastern limb during the period. Soundings suggest the most active of these regions may emerge on Day 3 or 4 (04 or 05 Apr) with associated minor uptick in risk projected.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	5	5	5	10
Very Active	R3 to R5 X Class	No	1	1	1	1

Solar Radiation Storms - (High Energy Protons):

High energy proton flux (greater than 10MeV), as observed by GOES-16 is forecast to remain at background levels pending any further developments.

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	1	1	1	1
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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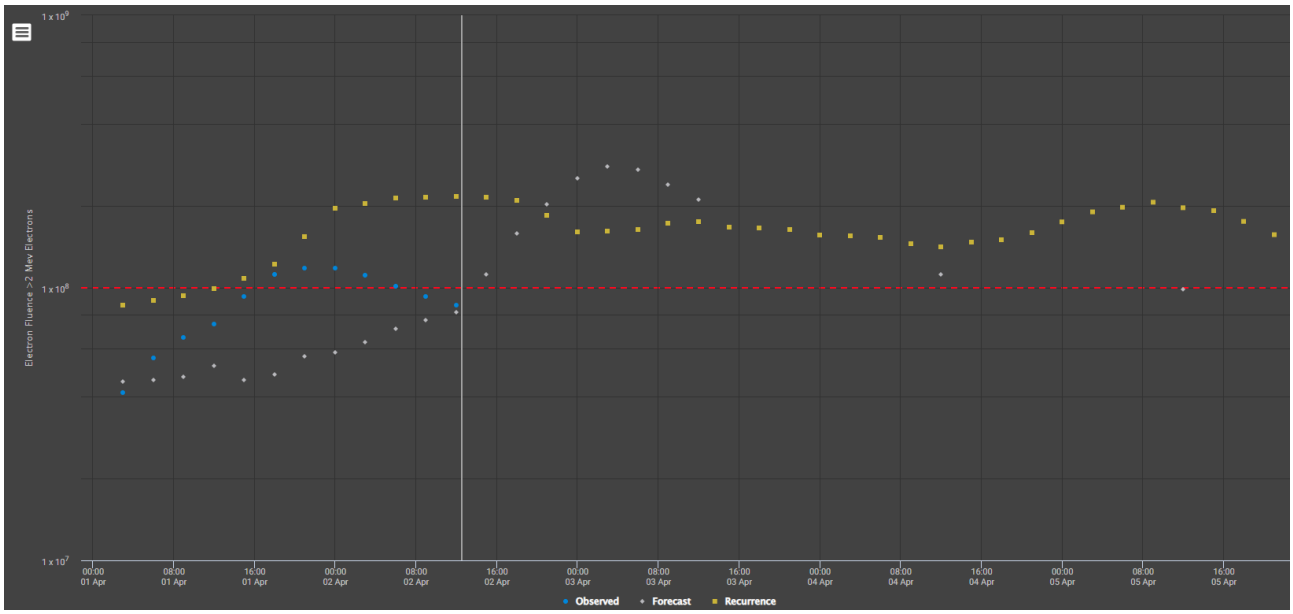
Figure 4: Latest MOSWOC REFM model output.



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High Energy Electrons Event (≥ 2MeV):
The flux at GOES16 was initially at High levels, but fell to Moderate at 01/2230 UTC where it has largely remained. As the influence of a HSS from CH88/- wanes later on Day 1 (02 Apr) into Day 2 (03 Apr) it is likely that diurnal fluctuations in electron flux will reach High levels. Geomagnetic activity forecast during the period (as a result of HSS and CME influences) may act to suppress observed flux values temporarily back towards normal background, adding uncertainty to the forecast. Fluence levels are currently just below the Active threshold, but are expected to increase to Active and generally remain so. However, uncertainty in the flux at GOES16 leads to reduced confidence in fluence levels during the period.
MOSWOC REFM forecast is thought to be giving a reasonable trend for Day 1, however, persistence is preferred from Day 2 onwards.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^{8}$	Yes	80	70	50	50
Very Active	≥ 2 MeV ≥ $1x10^{9}$	No	5	5	1	1

Figure 5:

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